REMARKS

This preliminary amendment presents a substitute specification, an abstract, and a new set of claims.

A marked-up copy of the substitute specification, showing additions to the translation by underlining and deletions from the translation by strike-through, is attached as Appendix III. The substitute specification includes no new matter.

Respectfully submitted,

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APPENDIX III

Description

Increasing the efficiency of hydrogen powered combustion engines.

EFFICIENCY INCREASE IN INTERNAL COMBUSTION ENGINES POWERED BY HYDROGEN

BACKGROUND AND SUMMARY OF THE INVENTION

[0001] The This invention relates to a process for introducing a medium that is combustible in a combustion engine, especially a cryogenic medium such as hydrogen, into a combustion engine.

[0002] Similar processes for introducing a medium, especially a cryogenic medium, into a combustion engine, exclusively used hydrogen. The modified Modified combustion engines have usually used a used hydrogen-suction-tube injection system, wherein said system systems which essentially corresponded correspond to the conventional suction-tube-injection systems used in conventional combustion-engines.

[0003] Because of the poor efficiency of combustion engines of this type using hydrogen-suction-tube-injection, the use of common rail high pressure injection systems is currently being tested.

[0004] Although a common rail high pressure injection ~~systems do~~ system will not significantly improve the efficiency of a combustion engine, ~~their~~ the use of such a system can increase displacement.

[0005] The disadvantage of the combustion engines with hydrogen suction tube injection currently used is that the gaseous hydrogen in the suction ~~tube displaces a~~ tubes displace considerable ~~portion~~ portions of the intake air thereby reducing the available volume of oxygen required for combustion. As a result, the displacement of a hydrogen-powered combustion engine ~~with a~~ with suction tube injection is significantly lower than that of a gasoline or diesel-powered engine.

DETAILED DESCRIPTION OF THE INVENTION

[0006] In ~~the~~ high-pressure injection of gaseous hydrogen in a closed ~~cylinder that~~ cylinder when a valve or valves are closed, this disadvantage is overcome. To reduce the energy required for compression, the gaseous hydrogen is injected into the closed cylinder preferably just prior to top dead center of the piston.

~~The temperature of the intake air at top dead center is approximately 275°C. If cold oxygen is injected into the combustion chamber of the cylinder at this~~

point, the compression temperature is decreased, thereby canceling out the energy required for compression.

The object of the invention is a similar process for introducing a medium, particularly a cryogenic medium, into a combustion engine that is free of the disadvantages described above.

The invention teaches that this problem can be solved by a similar process that is characterized by the fact that, prior to being introduced into the combustion engine, the medium is warmed up to at least the surrounding temperature, preferably at least 500° C and introduced into the combustion engine at a pressure between 100 and 500 bar, preferably between 200 and 300 bar.

The high temperature to which the medium introduced into the combustion engine is heated is determined by whether the air/fuel mixture in the combustion chamber of the cylinder is ignited by outside energy or is self-igniting.

In principle the temperature to which the medium introduced into the combustion chamber is heated, cannot be high enough. The upper

~~temperature threshold is determined in each case by the type of medium as well as the energy used for heating the medium.~~

~~The necessary injection pressure of between 100 and 500 bar can be efficiently built up, particularly when liquid hydrogen is used as fuel, in the hydrogen storage container while the medium is still in the fluid phase.~~

~~In an advantageous configuration of the inventive process for introducing a medium into a combustion engine, the medium is heated before being introduced into the combustion chamber at least partly through heat exchange with the single or one of the exhaust gas streams in the combustion engine.~~

[0007] The temperature of the intake air in the top dead center is approximately 275°C. If cold hydrogen is injected into the combustion chamber of the cylinder at this point, the compression temperature decreases and the energy required for compression is cancelled.

[0008] One object of the submitted invention is to propose a process for introducing a medium, especially a cryogenic medium, into a combustion chamber in such a way that avoids the disadvantages listed above.

[0009] In a process for solving this problem, prior to being introduced into the combustion chamber, the medium is heated to at least 500° C and is then introduced into the combustion chamber at a pressure between 100 and 500 bar, preferably between 200 and 300 bar.

[0010] The high temperature, to which the medium introduced into the combustion chamber is introduced, is also determined based on whether the air/medium mixture formed in the cylinder is ignited by outside energy or is self-igniting.

[0011] In principle, the temperature to which the medium introduced to the combustion chamber is heated cannot be high enough. The maximum temperature limit is determined in each case by the type of medium.

[0012] Especially when liquid hydrogen is used as fuel, the required injection pressure of 100 to 500 bar can be efficiently achieved in the hydrogen storage container while the medium is still in the fluid phase.

[0013] According to an advantageous configuration of the inventive process for introducing a medium into a combustion agent, the medium is heated prior being introduced into the combustion engine at least partly from

heat exchange with the single exhaust gas stream, or a single one of the exhaust gas streams, of the combustion engine.

[0014] ~~In~~ Along with the configuration of the inventive process described above, alternative or supplemental processes, ~~can be considered,~~ such as, for example, electrical heating, heating through combustion of a portion of the medium, etc, can be considered. These alternative or supplemental processes are advantageously used primarily during the starting phase of the combustion engine.

[0015] The inventive process for introducing a medium into a combustion chamber allows the efficiency of a combustion engine to be increased up to approximately 50%. Each increase in efficiency, however, is a function of the selected compression ratio as well as the selected injection pressure.

[0016] The concept described above is for use with all mediums used as fuel, which do not fail or crack at the temperatures realized. When these fuels are used, the pressure is increased in the fluid phase and afterwards dampened in front of the injection nozzle.

[0017] If gaseous fuels, such as natural gas of GH_2, are used, only a portion of the energy can be yielded, since the fuel must be compressed. However, this is aided by the fuel tank pressure in the storage container.